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A STUDY OF PURPOSE. III

THE RÔLE OF PURPOSE IN NATURE

WE have seen that the concept of purpose is based on a certain conscious experience. The distinctive feature of the purposive experience is that the usual order of sequence between presentation and representation is inverted. The ideational experience which forms the first stage of purpose is termed *forethought;* the progress and fulfilment of the purpose are accompanied by a feeling of *fitness,* or by a contrary feeling if the fulfilment is impeded.

Our study of objective purpose indicates the presence of corresponding factors in behavior and growth. The analogue of forethought is an *anticipatory reaction;* the analogue of the fitness-sense is a judgment by the observer: when the outcome conforms to the scientist's ideal he judges it *fit,* when it fails to tally with this ideal he deems it *unfit.* On the basis of this similarity we are justified in extending the notion of purpose to certain biological phenomena, in which an inversion of temporal order is observed.

It remains to consider whether the category of purpose may be carried over into the inorganic sphere. Do any transformations or motions of physical things (apart from those pertaining to biological organisms) anticipate the future? This in turn suggests a still more fundamental question: Does science find any substantial indications that the constructive make-up of nature as a whole is purposive and that the succession of events in cosmic history constitutes a purposive series?

The scientist's problem is this: So far as we know at present the constitution of nature is quite empirical. It might have been quite different in many respects. The chemical elements might have been different, or the existing quantity of each might have been more or less than it actually is. The physical laws might have been different, or the grouping of masses into worlds and the material composition of these worlds might have been otherwise. If all physical nature is empirical, we may ask, (1) Does the actual constitution of nature give evidence of a purposive *origin?* In other words, may we conclude on scientific grounds that its actual formation was anticipatory of the stages which evolution has undergone and will undergo? (2) Does the *evolution* process itself furnish evidence of anticipation and purpose? The problem of origin seems to involve an entelechy, since the beginning of the physicochemical series, if there was such a beginning, could scarcely itself be expressed in mechanistic terms. The problem of evolution is merely a generalization of the biological problem. If cosmic evolution as a whole *should* prove to be purposive, the purposive relation involved might be either entelechial or mechanistic.

We find, then, three fairly distinct problems confronting us: (1) The existence of purpose in *inorganic processes* similar to that which clearly occurs in the organic realm. (2) The purposive *origin of the universe.* (3) The purposive character of *cosmic evolution* as a whole.

It may be well at the outset to justify the attempt to examine these problems from a purely scientific standpoint. For, owing to the absence of any very clear empirical evidence on the subject, scientists are generally inclined to avoid the teleological problem as applied to inorganic nature. Some investigators hold that the problem is insoluble—that the answer is really "unknowable." Others insist that its solution transcends the bounds of scientific procedure and that an answer may only be obtained by non-scientific means, through the medium of philosophy and theology.

Neither of these seems the proper attitude for the scientist to take. (1) To hold that any phenomena are unknowable is distinctly unscientific. In many cases science has discovered new paths leading to the solution of seemingly insoluble problems. Spectral analysis revealed the chemical composition of distant stars, which had been assumed to be beyond the range of human knowledge. The most that the scientist may venture to say of any problem is that the answer is *unknown.* It is provincial if not paleolithic to declare any truth *unknowable.*

(2) To relegate the problem of teleology to philosophy and theology was a defensible attitude in pre-Darwinian times. There was then no scientific means of explaining the mechanism of purpose, whereas both of these branches claimed to possess a master-key to certain obscure problems of the universe. Now that biological science offers a definite explanation of purposive behavior, the relation of purpose to cosmic progress becomes an actual scientific problem. Whether or not the attempt prove successful in throwing new light on the trend of the universe, science seems called upon to investigate the problem of purpose to the very foundations according to its own methods.

Before beginning this study it would be well to recall once more the distinction between the mechanistic and vitalistic conceptions of purpose. The mechanist regards the purposive relation as *supplementing* the causal relation. Purposive phenomena, according to his view, are also causal phenomena. The succession of physicochemical processes in purpose is continuous, just as it is in pure causation. There is merely an *additional* relation between certain terms, which is the inverse of causal antecedence and consequence.

The vitalist, on the other hand, regards the purposive relation as *counteracting* or *superseding* the causal relation. According to his view there are in purposive phenomena one or more "uncaused" terms. Either the future in some way changes the present; or else some agency outside the series of events exerts a guiding influence upon their succession, so that events take a different course from that brought about by physical causation. The latter interpretation I understand to be Driesch's position. The supposed guiding agent, entelechy, may be part and parcel of the "material substance" or intimately associated with it; but one of its distinctive features is that it lies "outside the causal series."

It is somewhat difficult for a mind trained in the study of physical and chemical relations to picture such an entelechy or to understand the nature of its activity. But inasmuch as some earnest and well-trained observers do accept it, the hypothesis deserves serious consideration by scientific thinkers. Its validity should be determined by *evidence,* not by the test of *conceivability.* It is not sufficient to waive entelechy aside on the ground of inconceivability; for certain inconceivable hypotheses have ultimately worked their way into general scientific acceptance.[1]

The chief stumbling-block to the mechanistic interpretation of mental and biological purpose has been the potent, *directive* factor. We found reason to believe that this is only a psychomorphic adjunct to purpose. In the organic realm the mechanistic view, which rejects this factor, seems to be supported by the weight of evidence. The issue between vitalism and mechanism in the inorganic world should likewise be determined according to scientific evidence.

1. *Purpose in the Inorganic Processes.*—Our first problem is to determine whether any inorganic transformation gives evidence of possessing a purposive character. We shall base our inquiry upon the two distinctive factors discovered in purposive behavior, *anticipation* and *fitness,* and begin with an examination of the former.

(*a*) *Anticipation.*—Do inorganic activities in any way anticipate the future? Do they ever prepare for or refer to later situations?

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[1] One leading aim of these papers is to urge a serious consideration of the entelechy hypothesis and its rejection on the evidence.

Physical events in general constitute an irreversible series—or, more exactly, a "non-reversing" succession. The motion of a material body tends to continue in the same direction indefinitely. When a moving body is deflected by some force or obstacle, it seldom retraces its course in precisely the opposite direction. When a mass of earth or rock disintegrates, its particles scatter far and wide and never return to reconstitute the original mass.

Certain physical phenomena indeed are *rhythmic;* this is particularly the case with simple motions, such as light and sound waves or the swing of a pendulum. The tides furnish an example of a rhythmic series on an unusually large scale. Closer examination, however, demonstrates that tidal rhythm is not a perfect reversal of events; winds and reefs often alter the course of the flow and transform tidal action into a succession of progressive changes. The same is true of the simpler rhythmic motions. Friction, atmospheric disturbances, and other influences modify sound vibrations and pendular movement.

Instances of *simple reversal* occur in the transformations of bodies from one state to another and in chemical activity. Water is transformed into steam or ice, and these bodies may return again to the liquid state. Chemical compounds are formed, and under certain conditions the compounds are transformed back into their elements. But the reversal seldom brings about an exact reconstitution of the original situation in every particular. Some of the ice evaporates before the rest is transformed into water. Part of the chemical compound unites with some other substance to form a new compound before the remainder has been resolved back into its elements.

A *cyclic* form of motion occurs in certain physical phenomena, such as the revolution and rotation of planets. But here, too, the recurrence of phases is imperfect. The rotation of the earth is subject to constant alterations; the earth's orbit is forever contracting. The more closely we examine nature, the less evidence do we discover of any complete reversal of serial order, or any exact cyclic repetition of events in the inorganic sphere. The general pattern of physical change appears to be a progressive, non-reversing series of transformations.

So far from raising an initial presumption against the teleological hypothesis, however, this general irreversibility of physical events is quite consistent with a purposive interpretation. For the reversal of events which characterizes purpose is not a complete retracing of the process step by step in the opposite direction. Anticipation is only an inversion of the order of *certain events* in the series. In the ordinary causal sequence represented by A, B, C, D . . . L, M, N, O, the event B is the usual antecedent of L, M, N, O. In purposive activity certain of these events, M, N, come to be antecedents of B; the series becomes A, M, N, B, C, D . . . L, O. When the medusa, acting upon an olfactory stimulus (A), begins its food-getting reactions (M, N) before the food is grasped (B), this reversal of order stamps the act as purposive.

Are there indications of such anticipations in the inorganic world? Do we find any chemical or physical activities which begin before their antecedent conditions are completely established? Up to the present I have been unable to discover, outside of the organic sphere, any *unquestionable* example of anticipation. In popular language the sun "struggles" to pierce the clouds and pour its warm rays on the earth. Even were all the sun's rays concentrated on the earth, instead of an infinitesimal portion, it would be difficult to discern anything anticipatory in the "act."

The relation between clouds and rivers furnishes a less fanciful example. The sun's heat evaporates water from the sea, the temperature cools and precipitates rain, which gathers in springs and streams and passes at length into the great rivers. The formation of clouds, then, is in a way an anticipation of the river's flow. It serves to maintain the streams at a fairly constant level.

We may cite also the successive formation of strata in the earth's crust by precipitation of lime, basalt, and other substances. The older teleology would interpret the stages in the process as "means" to an "end,"—namely, the production of the solid earth. But does it involve real anticipation? Does not the causal relation describe it fully? In such cases does the future outcome add any new meaning to the successive stages of the process?

Certain mechanical devices of human origin manifest anticipation. The governor on a wheel keeps the speed constant. If the wheel begins to rotate faster the weight flies out and checks it; if the wheel slackens the weight is lowered and the diminished friction causes the speed to increase. There is no doubt but that the presence of the governor anticipates the irregularities of the wheel's motion. In certain motor engines immediately after combustion a valve opens through which the waste products pass out. The opening of the valve is anticipatory to the discharge.

Numerous examples of this sort might be mentioned, but they are scarcely relevant here, since they all originate in the activities of human organisms. They do serve, however, to demonstrate one fact, —namely, that mechanistic processes *may* fall into the purposive type. One would scarcely attribute a resident entelechy to the regulator. On the other hand, in all these cases the purposive type of activity is built up through the interaction of organisms with these inorganic bodies. The inorganic bodies do not of themselves assume the purposive type of activity. Clerk-Maxwell suggested that a guiding "demon" might enable heat to pass from a colder to a warmer body; but he pointed out at the same time that the heat activity does not of itself accomplish this reversal.

In living matter we find abundant instances of anticipation, as already indicated. It should be noticed also that in the course of evolution, taken as a whole, so-called intermediate forms appear—rudimentary organs and transitional species,—which seem explicable only through references to other forms which appear later. Anticipation is so marked a characteristic of biological phenomena, that the most mechanistically inclined biologist finds it difficult to dispense altogether with teleological language in discussing growth and behavior. On the other hand, when we study the "behavior" of chemical elements, the evolution of the stellar universe, and the formation of the earth's crust, it is difficult to discover a single indisputable instance of anticipatory activity. Does this indicate that anticipation is a phenomenon which belongs exclusively to biological organization?

I am not sure that so sweeping a conclusion is justified. (1) The anticipatory behavior of organisms depends on complex structure. Outside of the organic realm we have little opportunity to observe very complex colloidal compounds. If anticipatory activity depends upon *complexity* (and upon *organization* in the broad sense of orderly complexity), is there any but negative evidence to warrant us in limiting the sphere of anticipation to *biological* organization, *i. e.*, to the orderly complexity of carbon compounds?

(2) It appears from observation of organisms that the greater the degree of organization, the further-reaching and more detailed is the anticipation. This in itself would lead us to expect only rare and crude instances, if any, among simple inorganic phenomena.

(3) The example of the mechanical governor would seem to refute the assumption; for a crude speed regulator might conceivably come into existence by some fortuitous combination of substances. A natural dam may approximate a type of water-gauge.[2] The complex interworking of cloud-formation and river-flow may also serve as an argument for anticipation in the inorganic sphere. One single exception destroys the generalization.

(*b*) *Fitness.*—In the activity of organisms the fitness factor is a judgment by the observer that the outcome of the activity conforms to a type or to a general ideal. The dog's food-getting reaction is fit when it results in his capturing and devouring the prey. Or, in the broader aspect, it is fit when it serves to maintain the dog's life. From this broader viewpoint we would not judge the devouring act to be fit if the prey devoured is poisonous.

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[2] These two illustrations were suggested by Professor R. S. Lillie's reference to the safety-valve in his admirable paper on "Purposive and Intelligent Behavior" (this JOURNAL, XII., page 604). The first two parts of the present paper were completed and the third part outlined before the writer was acquainted with Professor Lillie's article.

The physical sciences proceed on the assumption of uniformity. So far as conditions are the same the mechanical activity is exactly the same; and so far as they differ the activity does not conform to the assumed type—it is not "fit" in that sense. We are accustomed in experimental work to solve the question of conformity by mathematical criteria. Take the problem of the atomic weight of hydrogen in relation to oxygen. Based on $O=16$, a number of independent tests give values for H varying between 1.0075 and 1.0085. The investigator assumes the average or median as type, and estimates the relative fitness of the particular tests according as they approach this standard.

The criterion of fitness may be used to determine the purposiveness of an activity where its anticipatory character is in doubt. For example, take the sequence of evaporation from the sea and the flow of rivers. If we regard a certain height of water in the river as the type, then a given amount of evaporation and rainfall leads to a fit outcome. A greater or lesser amount of evaporation is to this extent unfit. But how are we to determine the "standard" height of water? In animal behavior we found difficulty in setting particular norms, for the reason that behavior different from the norm was sometimes judged fitter than that which conformed. In the river-level problem it is far more difficult to select a norm. Is the norm a steady level, or an average level with fluctuations, or a progressive lowering of level as the stream cuts its way deeper into the bed? If the river breaks its banks and floods a marsh-land, is this outcome fitter or more unfit? It is difficult in studying such activities to form any solid judgment of fitness with reference to a particular norm.

How is it with general norms or ideals? The ultimate criterion of fitness in the organic sphere proved to be the maintenance of the individual life or the persistence of the phyletic chain. The nearest approach to this among inorganic phenomena is the maintenance of an object's form despite changes of substance. Thus a river maintains itself, although the water is constantly replaced by other water. There is a seductive analogy between this and the maintenance of organic life through all the creature's metabolic changes. If we consider the maintenance of water in river-beds as a general norm and the evaporation from the ocean as an anticipatory action, we may attach a judgment of greater or less fitness to the rainfall in wet and droughty seasons, respectively.

The scientific physiographer would probably adopt this interpretation. If physiography is a real science, it would seem possible to extend the notion of purposive activity to such phenomena as these. We may even find in physiography examples of "adaptation"—that is, modifications which render the activity more fit.

A volcano builds itself up by means of its own activity. The lava which it throws out collects in a cone, while the continual passage of material from the inside keeps open a vent and maintains a funnel-shaped passage. This passage is lengthened more and more as the mountain grows higher. In the nature of the case more material flows to the base than collects at the summit, so that the sides of the volcano maintain a curved slope which forms a suitable incline for the flow of lava. The action at any moment is fit, but the modifications render it *more* fit. In other words, the activity "adapts" itself to each phase of the changing conditions.

Again, a river gradually wears away its bed. The swifter current in mid-stream makes that part deeper; the banks are cut down so as to give clearly marked limits to the channel. The general action of erosion is *anticipatory,* in that it prepares the river bed for the continued flow of the river. Each step in the erosive process is also an *adaptation;* it renders the river-bed more fit for the flow of the current.

Should activities of which the above are instances be included under the concept of purpose? From the physiographer's standpoint this extension of purpose is legitimate, for they bear the distinctive marks of purpose—anticipation and fitness. The biologist may object that the river and the volcano are not unitary things in the sense that organisms are units. But are not the cell and the organism also groups of particles from the physicist's standpoint and groups of atoms from the chemist's?

If biology has a right to adopt an arbitrary unit which suits its needs, can it refuse to recognize the right of another science to adopt the unit which *its* data justify? Each science is the best judge of its own requirements. The real question is whether physiography is a science—or rather, whether its data admit of scientific treatment. It would be difficult for the biologist to defend his own science against the physicist and at the same time combat the claims of physiography. I believe there is some ground, then, for extending the concept of fitness into the inorganic realm, though little progress has actually been made in this direction.

This extension, however, serves only to emphasize the mechanistic interpretation of purpose. For it is doubtful whether any scientific physiographer would seek to account for the process of river-maintenance and volcanic action by the directive agency of an entelechy.

We may conclude, then, that there are some few scientific indications of "purpose" in the inorganic realm, and that the evidence certainly precludes a sweeping denial of its *possibility* in that sphere. So far as the actual evidence goes, however, the indications favor the mechanistic interpretation rather than the vitalistic.

2. *Purposive Origin of the Cosmos.*—So far we have considered only specific types of inorganic activity. Quite a different problem arises when we examine the character of the *ultimate data* which compose the inorganic world. Do the make-up of atoms and electrons, their spatial relations and "forces," their modes of composition, their actual distribution, etc., indicate a preexisting "plan"? We have only the later terms of the series to go upon. If an anticipation stage existed, we have not observed it. I see no way of studying this phase of purpose from the standpoint of *anticipation;* our only avenue of approach, apparently, is from the side of *fitness.*

The question of *entelechy* stands on quite a different footing in the explanation of origins from its place in the explanation of changes. In the latter it seems to be wholly discredited. In the problem of origins, however, the issue between entelechy and mechanism is still open so far as our present survey is concerned. Even though there be no directive potency in consciousness or in organisms, a directive factor may prove requisite to account for the beginning of the things which are.

Certain writers have recently endeavored to reinstate the earlier cosmic teleology, and to demonstrate that the actual constitution of the universe is peculiarly harmonious, a conclusion which seems to indicate a preconceived design. For example, the existing range of temperature on the earth is favorable to rainfall, which produces the streams, which cause erosion, which renders the soil favorable for vegetation. Similarly they conclude that initial prevision is evidenced by the great abundance of those elements which are most important for the preservation of life. In each of these instances, as in almost all that are brought forward to sustain the contention, there is some reference to life. But the purpose here considered is not a biological act—it is rather the fitness of inorganic conditions to produce and maintain vital organization. Such examples of the peculiar fitness of inorganic conditions might be multiplied. Several writers have traced them out in great detail.[3]

There is, however, a fundamental scientific objection to this mode of reasoning. Admitting that inorganic conditions are peculiarly suitable to the maintenance of life as actually constituted, it may nevertheless be argued that under a different set of inorganic conditions a different type of organism might have arisen for which those alternative conditions would have proved just as favorable. It is not reasonable to infer design from the fitness of present conditions, unless at the same time we can show that any other conditions would have resulted in hopeless chaos. At present there are no means of demonstrating this. On the contrary we do find certain inorganic phenomena, such as the properties of silicon compounds, which suggest that on a planet where carbon was scarce a different type of organism might well have arisen based upon some other element.

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[3] See especially the recent work by L. J. Henderson on "The Fitness of the Environment." Professor Henderson holds that the cosmic process is strictly mechanistic, but that there may be a tendency which works "parallel with mechanism without interfering with it" (p. 306)—this tendency being located "at the very origin of things, just before mechanism begins to act" (p. 308). It is interesting to note that Professor Henderson assigns teleology to a realm outside the domain of science (p. 311).

The attempt to infer design from the peculiar fitness of actual physicochemical conditions rests mainly upon enumeration of particulars. In the interest of fairness the evidence for the other side should be presented. Unfortunately no one has undertaken, so far as I am aware, to enumerate systematically the points of *unfitness* which inhere in the actual constitution of matter, its properties, and its relations.[4] It is not easy for us to imagine a universe of other sorts of atoms with other properties and relations. The scientist may concede his own inability to picture things as they might be, without being at all convinced that they might not be different, and that the constitution of such hypothetical things might not be better fitted to secure an harmoniously working universe. In short, the arguments so far advanced for "peculiar fitness" lead merely to the meaningless conclusion that the fitness of things is what it is.

The attempt to read purpose into origins by such arguments as this is merely an extension of the vitalistic conception of purpose from the biological sphere to the problem of cosmic origins. At any given instant (it is argued) the position of events would "naturally" be so-and-so; but at certain critical moments entelechy steps in as a directing force and alters the "natural" sequence of phenomena. So too it is assumed that at the origin of things their constitution might have been this, that, or the other; an entelechy steps in and directs what they shall be. We have seen, however, that there is no empirical ground for the belief that at any instant a directing force alters the mechanistic course of events. Why then should the scientist carry this discredited notion over into the sphere of origins, about which he knows far less?

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[4] According to all indications, in the actual physical universe the dissipation of energy will ultimately reduce any given world to a cold, solid mass, on which life as we know it will cease to exist. Surely this is a supremely *unfit* character in the constitution of things!

The philosopher will obtain scant hearing among scientists if, after conceding the mechanistic character of biological events, he attempts to smuggle entelechy in at the beginning of things. A notion accepted in one sphere may be carried over by analogy into another with some plausibility. But if it afterward prove false in the former sphere, one should demand independent evidence if it is to stand in the latter. If the action of a directing agency during the *course* of events is unsupported by evidence, there is no *a priori* ground for assuring such a directive agency at the *beginning* of events.

The present findings of science, however, indicate rather a world without beginning in time. If the succession of physical changes has proceeded from all time, there is surely no question of a directive agency at the beginning. The scientist will not go so far as to assert the *impossibility* or *inconceivability* of a beginning, or of an entelechy in that beginning. He will merely note the entire absence at present of evidence to support the hypothesis.

3. *Purpose in Cosmic Evolution.*—It remains for us to consider the relation of purpose to the progress of events in the universe taken as a whole—or rather in that fragment of time and space open to modern scientific observation. The notion of evolution in its broadest aspects covers the growth of stellar systems, the integration of single worlds like the earth, the chain of living species, and social organization. This dynamic concept is to-day firmly established in science. It points to a progressive change, rather than an ebb and flow of events—to new stages of organization and novel results attained in the course of history. The evolution concept *per se* involves nothing which may not be stated in purely causal terms. But the occurrence of anticipation and prevision in certain portions of the general system is definitely established. Can this notion of purpose be extended to the course of cosmic history regarded as a single interwoven plexus of events?

So far as the *vitalistic* interpretation of purpose is concerned, it is difficult to find any warrant for such an assumption. The facts in biology on which the notion of a directive entelechy are based have been shown to lend themselves readily to a mechanistic explanation. Inorganic phenomena require even less the support of an entelechial hypothesis. Natural selection seems an adequate substitute for prevision in the interpretation of organic evolution, and we find nothing in the processes of inorganic evolution which indicates the action of a directive force outside of the causal chain. Scientific evidence, then, leads clearly to the rejection of the entelechial assumption in interpreting the course of cosmic evolution.

There remains, however, the possibility of extending the *mechan-*

istic interpretation of purpose to the cosmic process. We have endeavored in these papers to work out a scientific conception of purpose which avoids the implication of a potent, directive agency. Purpose in the last scientific analysis implies only anticipation and fitness. Do we find evidence of these factors in the cosmic process as a whole?

The mechanistic standpoint is an attempt to explain organic phenomena in physicochemical terms. In so far as this attempt is successful, the gap between inorganic and organic processes is bridged. When, therefore, the mechanist comes to consider the rôle of purpose in the universe, his fundamental assumption makes it feasible for him to group the organic with the inorganic. That is to say, the mechanist finds no ground for setting organic phenomena off by themselves. He regards the entire course of evolution as a single graduated process.

The only scientific basis, in our present state of knowledge, for the extension of the category of purpose to the course of cosmic evolution seems to be the general orderly interweaving of natural processes in their mutual interplay, and their progress toward a preconceivable goal. The physical universe, even apart from organic life, is a cosmos, not a chaos. The uniformity of nature, the prevalence of the same chemical and physical "laws" throughout the vast extent of space and time which are within scientific observation, the conservation of energy, the wide reach of light, gravity, etc.,—all these empirical generalizations testify to a general unity of composition and unity of action in nature. There is present something more than fitness—there is evidence of *harmony* of all processes.

Science can not infer with certainty that this general harmony implies *anticipation*. But there is apparently a certain *trend of events* which may be noted even with our present limited knowledge. With the further advance of knowledge it seems likely that the direction of this trend will become more clearly evident. In other words, it seems possible that the fulfilment of the cosmic process may be anticipated or foreseen in human knowledge.

Unfortunately this type of prevision does not meet the conditions of purpose according to the mechanistic interpretation. For the anticipation of events implied in mental and biological purpose is a temporal inversion *in the series of events themselves,* not in a separate thought-series. Our thoughts, or their physical bases, form part of a world-wide causal sequence, it is true, but they constitute only a minute portion of the vast complex sequence which embraces the whole course of cosmic evolution. Without insisting too dogmatically on the parity between antecedent and consequent, we may nevertheless hesitate to call any individual man's knowledge a "preparation'' for the vast future course of the world's evolutionary progress. The successive steps in the general cosmic evolution, according to all present scientific knowledge, do *not* anticipate future steps, in the sense of preparing for them. Whether an extension of knowledge will reveal any such preparatory or anticipatory action in the process itself, it is beyond the province of this study to suggest.

In the absence of direct evidence for *anticipation,* we can only point to a substitute conception, *trend.* There does appear to be a general trend of events toward more complex organization, better adaptation, and moral improvement. What we know of stellar evolution points to a trend in the direction of complexity and harmonious organization. The evidence from the organic world is far more significant. The trend of organic evolution appears to be a steady advance; the later forms are more complex, fitter, better, than the earlier. Despite the ''struggle for existence'' there is a general cooperation of action among species—an interworking of the several processes of multiplication, destruction, and variation. The organic world is apparently working out its own destiny in a well-rounded manner.

The real value of this evidence it is difficult to estimate accurately. One is prone to attach undue weight to particular phases of evolution. The appearance of plant life on the earth, the rise of man, the defeat of a barbarian horde, impress the student of certain sciences as being crucial events. They do not seem especially significant, however, when we consider the aeons of time and the vast stretches of the stellar universe. The only conclusion of universal importance which science yields in this matter is that there is a general trend of cosmic evolution ''upward.''

To the exact scientist, as Bertrand Russell suggests,[5] the evolution of biological forms seems trivial compared with the immutable laws of inorganic matter. The history of higher intelligence and social organization on one minute planet for some 10,000 solar years seems but a single tremor in the pulse of time. The conquests of Alexander or any other terrestrial event look small in perspective. On the other hand, from the standpoint of *values* the appearance on the scene of rational beings, capable of ethical judgments, seems to mark a tremendous leap in advance.

Allowing for the natural bias of both parties, I believe we may grant the existence of a ''trend'' of some sort in cosmic history, to which the judgment of ''harmony'' is attached. Harmony may be only a broader conception of *fitness,* but *trend* is not equivalent to anticipation or *preparation.* Unless the meaning of purpose be considerably revised, it does not seem applicable to the general course of cosmic events.

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[5] ''Our Knowledge of the External World as a Field for Scientific Method in Philosophy,'' pages 11 ff.

It is one thing to quibble over terms, and quite another matter to attach clear and definite meanings to the terms which are employed. We have endeavored to attach a definite scientific meaning to the vague popular notion of purpose. Our analysis fixed upon the "reversal of sequences" as the fundamental characteristic of scientific teleology, the adequacy of the inversion being estimated in the judgment of fitness. The notion of a *trend* appears to be somewhat different from this. It would only becloud the issue to include it under the idea of purpose. For this reason, while we may conclude, on the basis of empirical evidence, that "history" in its widest sense shows a *trend,* our present scientific knowledge does not indicate that it manifests a *purpose.* Whether scientific investigation will ultimately succeed in discovering a teleological character in cosmic evolution, is for the future to determine. We should reserve judgment till crucial evidence is at hand.

Up to the present, science has discovered only meager data for the extension of the purpose category below the organic realm. While the concept proves extremely useful in biology and psychology, the causal category is the all-important mode of interpreting inorganic phenomena. Philosophy and primitive science, starting as usual at the wrong end of the series, have read the higher into the lower. They have overestimated the importance of purpose in cosmic events, just as they have overestimated the importance of the kinesthetic factors in purpose itself. The voluntaristic philosophy of Schopenhauer and Nietzsche, the entelechial philosophy of Driesch, are but exaggerated instances of this widespread tendency.

Mechanistic science finds a place for teleology in the world. But the purpose which mechanistic scientists recognize is not the *entelechy* of the vitalist; it is a principle of transformation which cooperates with causation, not an efficient agent which plays havoc with causal transformation.

SUMMARY

Our study of purpose covers three separate fields: the conscious experience, the "objective" biological phenomenon, and the rôle of purpose in the general scheme of nature. We considered the psychological problem first, since the notion of purpose is found to be based on a certain conscious experience.

1. *Purposive Consciousness.*—The distinctive feature of the purposive experience is the inversion of the usual time order of certain events. Representation precedes presentation, the general precedes the particular.

Our analysis of the purposive consciousness brought to light five factors. (1) *Forethought,* the most characteristic factor, is an idea or image which carries with it a reference to the future. (2) *Assent,* which attaches to every forethought, is based on certain kinesthetic memories. (3) *Potency-feeling,* the feeling of an efficient force in the forethought, is based on the kinesthetic sensations which accompany muscular tension in movement. (4) The *self-notion,* or personal reference in purposive acts, is based upon the kinesthetic data which attend all personal activity. (5) The *sense of fitness* accompanies the fulfilment of the forethought and certain intermediate steps; it is a judgment that the experience corresponds to the forethought. Its opposite form, the sense of unfitness, is a judgment of non-correspondence. This factor, like the first, is very characteristic of purposive experiences.

The three kinesthetic data—assent, potency-feeling, and self-notion—are incidental accompaniments. They have all acquired undue importance in the psychological analysis of purpose. In particular, the overestimation of the potency-feeling is responsible for the common theory that the forethought has power to effect its own fulfilment by an autonomic selection and guidance of events. It has led to unscientific and mystical interpretations of volition, which closer analysis fails to justify. The fiat is only assent reinforced by a feeling of dynamic efficiency.

2. *Purposive Activity.*—Our study of purposive activity in organisms included both behavior and growth. Purposive activity as observed in organisms is characterized by only two of the factors noticed in the conscious experience—*anticipation* or preparation, and *fitness* or adaptation.

(1) *Anticipation* is a real biological phenomenon. Behavior and growth are actually conditioned by the future as well as by the past. A later event is the basis of some earlier event, not merely its effect. That is, the usual temporal order of events observed in ordinary causal sequences is partly reversed in purposive activity. The embryo's growth has reference to the future adult state; a responsive act may begin before the situation to which it is a response is fully present.

Anticipatory behavior depends upon a set of mechanisms, especially the distant-receptors and the central nervous system. The phylogenetic acquisition of these mechanisms and their functions by organisms is sufficiently accounted for historically by chance variations and natural selection, since anticipation is generally beneficial to the creature.

(2) *Fitness,* the second factor, is not so much an observed phenomenon as a judgment by the observer. Scientists judge the fulfil-

ment of a purposive act by its correspondence with a type. In the final analysis a reaction or growth process is judged "fit" if it tends to prolong the individual's life or to preserve the species. An act or process which tends to end the creature's life or destroy the species is deemed "unfit." Between these extremes we find a graduated scale of fitness.

(3) The other factors which occur as accessories in the conscious experience of purpose have no counterpart in purposive activity. There is nothing in behavior or growth corresponding to the consciousness of "assent," "self," or "dynamic potency." Nevertheless these factors, particularly the sense of power in consciousness, have greatly influenced the scientific interpretation of purposive activity. They are largely responsible for the psychomorphic view of instinct and intelligence which characterized the earlier biology. The vitalist's entelechy is, in fact, an impersonation of these psychomorphic factors.

The extension of such notions as volition, indeterminism, and compulsion to the sphere of biological processes in the form of a guiding entelechy seems an assumption unwarranted by present evidence. The whole sequence of events in growth and behavior appears capable of explanation in mechanistic terms.

3. *Purpose in Nature.*—The rôle of purpose in the cosmos is a legitimate problem for science to face. (1) In the *inorganic sphere* there is no clear evidence of anticipation—that is, preparation—though a few facts, notably among physiographical processes, seem to indicate its presence. To these processes the judgment of fitness may be attached.

(2) When we consider the *origin* of the cosmos, the older purposive interpretation, founded upon entelechy, finds no support. For the entelechy theory rests upon a biological and psychological analogy, and scientific evidence in these two spheres is against the assumption on which the analogy rests. Entelechy, regarded as a potent, guiding agency, appears to be merely a psychomorphic element added to the notion of purpose. Without entelechy the very problem of origins vanishes, for science finds no other ground for assuming a beginning in the chain of natural events.

(3) Finally, if we seek for evidences of purpose in the general scheme of *cosmic history,* we find indications of a *trend,* but not of *purpose.* Science so far has observed no clear signs of anticipation in the general course of evolution, but only of a tendency toward greater complexity and harmonious interworking. What the future will discover remains to be seen. Present indications at least would lead us to judge that purpose is not a fundamental category in the scientific explanation of cosmic evolution. HOWARD C. WARREN.

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